

Title: Method of Annotating an Item with electronic data and apparatus therefor

5 Field of the Invention

 The invention relates to a method of annotating an item, in particular although not exclusively a document, with electronic data and apparatus therefor.

10 Background of the Invention

 Memory tags in the form of Radio Frequency Identification (RFID) tags are well known in the prior art. RFID tags come in many forms but all comprise an integrated circuit on which in use data can be stored and a coil which enables it to be interrogated by a reader which also powers it by means
15 of an inductive (wireless) link. Generally RFID tags are quite large, due to the frequency they operate at (13.56MHz) and the size of coil they thus require, and operate over large ranges and have very small storage capacities. Smaller RFID tags have also been developed, operating at various frequencies, but still having small storage capacities. Some RFID tags include Read Only Memory (ROM)
20 and are written to at the time of manufacture, whilst others have read and write capability. RFID tags have tended to be used in quite simple applications, such as for file tracking within offices or in place of or in addition to bar codes for product identification and supply chain management.

 One use to which such RFID tags can be put is the annotation of items,
25 such as documents, with data over and above that printed on them. For example in EP 1 076 316 A2 Eastman Kodak Company describe the use of an RFID tag of conventional form secured to a print, being an output image on a substrate, possibly of a photograph. The kind of data which it is envisaged will be stored in the RFID tag on the print relates to the manner in which the print has been

processed, particularly if the print is an output sheet from a proofing system. In any event the examples of data given range from 8 bits to 256 bits. A technique is described for communicating with multiple prints within range of the transceiver used to communicate with them, such as for example if a single
 5 print needs to be located amongst a file of such prints.

The present invention seeks to provide an improved method for annotation of items, such as documents, and apparatus for doing so.

Summary of the Invention

10 According to a first aspect of the present invention there is provided a method of annotating an item with electronic data comprising securing a memory tag to the item, the memory tag comprising a memory and a transponder to enable wireless communication with the memory tag, and having an external dimension D , wherein the memory tag is adapted for wireless
 15 communication only with a transceiver located within a distance of $10D$ of the memory tag.

The memory tag may be adapted for wireless communication only with a transceiver located within a distance of $5D$ of the memory tag.

The memory tag is preferably adapted for wireless communication only
 20 with a transceiver located within a distance of $3D$ of the memory tag.

The method may include securing a plurality of memory tags to the item.

Conveniently the or each memory tag is an RFID tag in which the transponder includes an antenna coil and all components of the RFID tag, including the antenna coil, are provided on a chip.

25 The item may be a document comprising one or more sheets of paper.

According to a second aspect of the invention there is provided apparatus for annotating an item with electronic data wherein the apparatus comprises a memory tag which in use is secured to the item, and a transceiver for wireless communication with the memory tag, the memory tag including a

memory and a transponder, and having an external dimension D , wherein the memory tag and transceiver are adapted for wireless communication therebetween only when the transceiver is located within a distance of $10D$ of the memory tag.

5 The memory tag and transceiver may be adapted for wireless communication therebetween only when the transceiver is located within a distance of $5D$ of the memory tag.

 Preferably the memory tag and transceiver are adapted for wireless communication therebetween only when the transceiver is located within a
10 distance of $3D$ of the memory tag.

 The apparatus may include a plurality of memory tags.

 Preferably the or each memory tag is powered as a result of wireless communication with the transceiver by inductive coupling.

 The or each memory tag preferably is capable of having data read from it
15 or written to it as a result of the wireless communication with the transceiver.

 Conveniently the or each memory tag is an RFID tag in which the transponder includes an antenna coil and all components of the RFID tag, including the antenna coil, are provided on a single semiconductor chip.

 The antenna coil may have five or fewer turns located around the
20 periphery of the chip.

 However preferably the antenna coil has two or a single turn located around the periphery of the chip.

 The memory may conveniently be FRAM or MRAM and preferably has a capacity of at least 0.5Mbits.

25 According to a third aspect of the invention there is provided an item annotated with electronic data stored on a memory tag secured to it, wherein the memory tag comprises a memory and a transponder to enable wireless communication with the memory tag, and has an external dimension D , wherein

the memory tag is adapted for wireless communication only with a transceiver located within a distance of 10D of the memory tag.

The item may be annotated with electronic data according to the method of the first aspect of the invention and this may be performed using apparatus
5 according to the second aspect of the invention.

Brief Description of the Drawings

The method of the invention will now be described, as will an embodiment of apparatus for implementing it, with reference to the
10 accompanying drawings in which:

Figure 1 illustrates a sheet of paper annotated with electronic data in accordance with the invention;

Figure 2 illustrates an RFID memory tag for use in the method of the invention;

15 Figure 3 illustrates the circuitry of the memory tag of Figure 2 and of a read/write device for wireless communication with the memory tag.

Detailed Description of the Preferred Embodiments

Figure 1 illustrates an item, in this case a sheet of paper 10, bearing
20 printing 12, which has been annotated with electronic data using a plurality of memory tags 14. The memory tags 14 have been secured to the sheet of paper 10 at various locations over its surface, although they may alternatively be embedded in the paper sheet 10, preferably in locations identified by the printing 12, in order to assist in locating them for the purposes of reading data
25 from or writing data to the memory tags 14.

A hand held read/write device 16 is used to communicate with the memory tags 14 in wireless manner, as will be discussed further below. The read/write device 16 is also connected to a host computer, display, data rendering device or other apparatus 18 from which the data for writing to the

memory tags 14 is received, and/or the data read from the memory tags 14 is passed.

Referring now to Figure 2, a schematic of a memory tag 14 is shown. The memory tag 14 is an RFID memory tag provided on a single semiconductor chip, and comprises an RFID transponder circuit 20, a memory 22, a power supply capacitor 24 and an antenna coil 26 having only a few turns e.g. five, or as in this case a single turn. The RFID transponder circuit 20 operates at 2.45GHz, is of an area of approximately 0.5 mm^2 , and will be described further below. The memory 22 provides 1Mbit of capacity of non-volatile memory and is of an area of approximately 1 mm^2 , and uses FRAM (ferroelectric random access memory) or MRAM (magnetoresistive random access memory) or similar memory technology requiring low power. The memory tags 14 are of a substantially square shape in plan view with an external dimension D for their sides of around 1mm.

Referring now to Figure 3, the circuitry of a memory tag 14 and circuitry 28 of the read/write device 16 are illustrated schematically, using conventional component identifications (C-capacitor, L-inductance, R-resistor, D-diode and S-switch). The RFID transponder circuit 20 of the memory tag 14 comprises a capacitor C2 which, in combination with the antenna coil L2(26), forms a resonant circuit with component values being chosen to tune the combination to approximately 2.45GHz for inductive coupling with the read/write device 16. The portion of transponder circuit 20 responsible for power supply is diode D1 and capacitor C4(24), with diode D1 rectifying the alternating current generated by the inductive coupling and the capacitor C4 acts as a power supply storage. The portion of the transponder circuit 20 responsible for receiving transmitted data from the read/write device 16 is diode D2, capacitor C5 and resistor R1 which form a simple envelope detector; the data thus received is stored in memory 22. The portion of the transponder circuit 20 responsible for the reading of data from the memory 22 is the tuned circuit L2/C2 in combination

with S1 and C3, switching C3 in and out of the circuit using S1 changes the resonance of tuned circuit L2/C2 resulting in phase modulation of the reflected power from the memory tag 14 to the read/write device 16.

The circuit 28 of the read/write device 16 comprises a signal generator 30 which generates a signal at the chosen frequency of 2.45GHz. This signal passes via an amplitude modulator 32, where it is amplitude modulated with data to be written to the memory tag 14, and a splitter 34, to an antenna L1 and capacitor C1 which form a tuned circuit. The component values of L1 and C1 being chosen to tune it to 2.45GHz, as for the tuned circuit in the memory tag 14, in order to maximise inductive coupling between the two circuits, and thus transmission of power and data to the memory tag 14.

The splitter 34 takes a part (as much as 50% of the power) of the amplitude modulated signal, for use as a reference signal, and passes it to a multiplier 36. The signal received from the memory tag 14, via the tuned circuit L1/C1 and divided from the outgoing signal by a coupler 38, is also passed to the multiplier 36. Thus the transmitted amplitude modulated signal and received signal are multiplied and then pass through a low pass filter 40 to provide a signal comprising the phase modulation from the memory tag 14 and thus indicative of the data read from the memory tag 14. This signal is then passed to the host computer or other device 18 to which the read/write device 16 is connected, for subsequent data processing.

One amplitude modulation format which may be used to apply the data to be transmitted to the 2.45GHz signal is Amplitude Shift Keying (ASK) which only requires the simple envelope detector D2/C5 described in the circuit 20. However, other amplitude modulation formats may also be employed. Further alternatives are Frequency Shift Keying (FSK) and Phase Shift Keying (PSK) that provide near constant envelope modulation, that is without any significant amplitude modulation, however these options have more complex

demodulation requirements and thus demand more complex circuitry in the memory tag 14.

With the apparatus of memory tag 14 and read/write device 16 described above power transfer of around 25% can be achieved with a distance of around 1.8mm between the antennae L1 and L2, of the read/write device 16 and memory tag 14 respectively. This is sufficient to transfer enough power to the memory tag 14 for it to operate.

The memory tags 14 have an external dimension D of around 1mm, as described above, and therefore the read/write device 16 can communicate with them over a relatively short range, in this example of approximately 2D, (as illustrated on Figure 1 by broken circle 17). However, the distance over which the read/write device 16 and memory tag 14 will communicate effectively will clearly vary with the exact details of their construction, and it may therefore be up to 10D. Distances greater than this would limit the ability to use a plurality of memory tags 14 on a single sheet of paper 10, or other item, due to the distances which would be necessary between the memory tags 14 to ensure that the read/write device 16 does communicate with the desired memory tag 14 out of a number present. To ensure that communication is with the correct memory tag 14 in every circumstance a communication distance of 5D or less is preferable.

The memory tags 14 will preferably have a data rate of 10Mbitss^{-1} , which is two orders of magnitude faster than is typical in prior art devices. Such a data rate would enable the read/write device 16 to be held over the memory tag for a very short period of time ("brush and go") for the data to be read or written as appropriate.

Although the memory tags 14 described above operate at 2.45GHz it should be understood that memory tags operating at other frequencies may be used to implement the invention. Factors affecting the choice of operating frequency for the memory tags are: a) government regulations concerning radio

frequency transmissions; b) adequate bandwidth (consistent with government regulations); c) frequency high enough to render the physical size of components in the memory tag small enough to keep the area of silicon required low (and hence the cost to manufacture low); d) frequency low enough
5 to provide adequate performance when using low-cost high-volume CMOS technology to manufacture the memory tag.